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Short Communication

Some Aspect of Modern Nanotechnology and Lazer Radiation in Cancer Treament

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This paper deals with the possibilities of applying modern technologies in biomedicine. The paper discussed a theoretical model, which enables a more detailed explanation of the processes that occour upon impact of laser beam on nanoparticles. The paper has presented a method that makes it possible to more effectively deal with the pathological formations. The paper also considers a relevant physic-mathematical model.

Keywords: Nanotechnice, Laser, Biotechnology, Nanomaterials.

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1. INTRODUCTION

Today, modern medicine makes extensive use of nanotechnology achievements that has led to the development of a new direction – nanomedicine. Nanotechnologies are currently undergoing clinical testing that will give us the opportunity to use them in medical practice. From the standpoint of modern medical science, the occurrence of pathology of an organ and pathology of the nervous system is based on a viewpoint, according to which, pathological formations are cell structures with changed parameters, that is a united, integrated system [1]. Systemic mechanisms of pathological disorders are manifested in various forms of pathology, at different levels of structural-functional organization of the nervous system, causing various pathological processes appear in various forms of disease. Methods of regulating the whole system of the organism – in various embodiments – are interdisciplinary scientific problem [2]. Proceeding from the fact that this issue – from the practical point of view – is very complex, a mathematical model is presented to solve it, that will relatively facilitate the control of treatment process, and, accordingly, it will be focused on results.

2. THEORETICAL MODEL

As shown by the experimental data analysis, when a nanoparticle or cell is being influenced by a laser beam, then, resulting from the optoacoustic method, there is an emergence of an acoustic wave. In addition, due to the influence of the acoustic wave, the irradiation occurs not only of the nanoparticle, but also of its immediate surroundings. At that time, there can be a bifurcation area formed in the immediate vicinity of the cancer cells. To explore this issue, it is advisable to consider the problem with a so-called distribution function, to find an inverse scattering function.

In order to solve the above task, we use Newton's approximate solution for the equation

$$\varphi(x) = F(x) - \boldsymbol{\alpha}; \quad 0 \le \alpha \le 1. \tag{1}$$

Here $F(x)$ – the distribution function.

As is known, the gradual approximation of Newton's solution method is easily achieved, if, during an expansion of the $\varphi(\chi)$ function in the Taylor series, we focus on the linear term [3, 4]. In case, during the expansion, we focus on the square term, then, using the approximation method for the equation $\varphi(\chi) = 0$, we will get for the resulting solution the following recurrent formula:

$$x_n = x_{n-1} + \frac{1}{\varphi''(x_{n-1})} \times$$
$$\times \left(\sqrt{[\varphi'(x_{n-1})]^2 - 2\varphi(x_{n-1}) \cdot \varphi''(x_{n-1})} - \varphi'(x_{n-1}) \right) \tag{2}$$

When

$$\varphi''(x_{n-1}) \neq 0,$$

$$x_n = x_{n-1} - \frac{\varphi(x_{n-1})}{\varphi'(x_{n-1})};$$

then

$$\varphi'(x_{n-1}) = 0;\ \varphi'(x_{n-1}) \neq 0;\ n = 1;\ 2;\ 3;\ldots$$

According to Taylor's formula, we may write:

$$0 = \varphi(x^*)\varphi(x_n) + \varphi'(x_n) \cdot (x^* - x_n) + \tfrac{1}{2}\varphi''(x_n) \times$$
$$\times (x^* - x_n)^2 + \tfrac{1}{6}\varphi'''(v_1) \cdot (x^* - x_n)^2 \tag{3}$$

On the other hand, for the quadratic approximation we will have:

$$\varphi(x_n) + \varphi'(x_n) \cdot (x_{n+1} - x_n) + \tfrac{1}{2}\varphi''(x_n) \cdot (x_{n+1}x_n)^2 = 0 \tag{4}$$

where $\varphi^{-1}(0) = x^*$.

In the paper [5], there is an image received for a linear approximation:

$$0 = \varphi(x^*) = \varphi(x_n) + \varphi'(x_n) \cdot (x^* - x_n) +$$
$$+ \tfrac{1}{2}\varphi''(v_2)(x^* - x_n)^2 \tag{5}$$

$$\varphi(x_n) + \varphi'(x_n) \cdot (x_{n+1} - x_n) = 0 \tag{6}$$

If we subtract the image (6) from the image (5), we will obtain:

$$\varphi'(x_n) \cdot (x^* - x_{n+1}) + \tfrac{1}{2}\varphi''(v_1) \cdot (x^* - x_n)^2 = 0 \tag{7}$$

from which

$$|x_{n+1} - x^*| = \frac{1}{2}\frac{|\varphi''(v_1)|}{|\varphi'(x_n)|} \cdot |x_n - x^*|^2 \quad (8)$$

The comparison of formulas (7) and (8) shows that in the case of the quadratic approximation, the rate of convergence is more than during the linear approximation, which is confirmed by an experiment, when the beginning x_0 is properly selected.

Furthermore, for the equation $\varphi(x) \equiv F(x) - \alpha$; where $0 \leq \alpha \leq 1$, $-F(x)$ – the distribution function, the image (1) will take the form:

$$x_n = x_{n-1} + \frac{1}{f'(x_{n-1})}(\sqrt{f^2(x_{n-1}) + 2f'(x_{n-1})[\alpha - F(x_{n-1})]} - -f(x_{n-1}) \quad (9)$$

from which

$$f'(x_{n-1}) \neq 0,$$

$$x_n = x_{n-1} + \frac{\alpha - F(x_{n-1})}{f(x_{n-1})}.$$

When

$f'(x_{n-1}) = 0$, $f(x_{n-1}) \neq 0$; $n = 0; 1; 2; \ldots$, where $f(x) = F'(x)$ – the distribution function, for which we may assume the existence of the derivative of $f'(x)$. It should be noted that the quadratic approximation, unlike the linear approximation, may be used even when the maximum point of $f(x)$ function is the value of the definable root.

3. DISCUSSION AND ANALYSIS

As is known, if there is an introduction of nanotubes and quantum dots, in order to activate them, laser radiation of nanometric range is used, the power of which is not big. At that time there is a so-called optoacoustic effect. It lies in the fact that it is possible to induce an acoustic signal due to thermal expansion of the environment during an absorption of the laser beam pulse.

Moreover, the stronger the laser pulse, the more powerful the acoustic signal. In addition, the sound – diffused by the nanotubes – can be observed through ultrasonic transducers. The presence of the signal – at the receiving ultrasonic transducer – indicates the existence of a bacterium in the process of blood circulation.

The model considered above can be used not only in the vicinity of occurrence of the optoacoustic effect, but also for studying the biophysical and biochemical processes. In addition, by means of the above presented formula (7) and (8), it is possible to calculate the current physical processes, which take place in the mentioned area, with a sufficiently high degree of accuracy.

On the other hand, if we have an overall picture of the processes occurring in cancer cell formation, then, by means of the discussed method, we can find the distribution function; in turn, it will greatly facilitate the process of a possible localization and treatment of a cancer (formation) disease. At the same time, it will be possible to use the nanotechnologies more effectively.

4. CONCLUSION

Thus, the efficiency of the method, presented in the paper, allows us to assert that due to its further development, it will be possible to solve the problem of recurrence of pathological processes at the cell level. In addition, the issue considered here requires further research and clarification of some details through clinical experiments. It is not excluded that the introduction of this method into practice will require a development of new technologies that will be associated with the regeneration of human body, an organ and the cell system; it makes possible to significantly increase the quality of treatment of various nosological forms of diseases, also at their early stage. Moreover, in terms of accuracy and possibility to achieve a desired result, the method has some advantages; therefore, it is worth to continue the research applying the method.

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